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CPW-fed Circular Slot Antenna for Ultra Wide Band Applications

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ABSTRACT
A planar circular patch monopole ultra-wideband (UWB) antenna is proposed for UWB communication applications. The desired band is realized by cutting of a T and I slot on a circular patch. The roles of various design parameters like S-parameters, current distribution and radiation pattern are studied. The proposed antenna has impedance bandwidth range from 4.6 GHz to 11.7 GHz and suitable for UWB applications.

Keywords
CPW feed, UWB.

1. INTRODUCTION
Ultra-wideband technology has been widely studied since the bandwidth of 3.1–10.6 GHz was released by the Federal Communications Commission (FCC) in 2002 for commercial applications due to its high data rate and low cost [1]. UWB have wide applications in short range and high speed wireless systems, such as ground penetrating radars, medical imaging system, high data rate wireless local area networks (WLAN), communication systems for military, and short pulse radars for automotive even or robotics. One of the key issues in UWB communications is the design of a compact antenna while providing wideband characteristics over the whole operating band. Due to the rapid development of such UWB system, a lot of attention is being given for the designing of the UWB antennas. This is quite challenging to satisfy the requirement of the UWB such as Ultra Wide Impedance Bandwidth, Omni-directional radiation pattern, constant gain, high radiation efficiency, constant group delay, low profile and easy manufacturing [2]. Various antenna configurations includes planar monopole antenna, slot antennas and dipoles have been used. Among several antennas planar monopole antennas are good candidates for wide-band applications, as they exhibit wide impedance bandwidth, compact and simple structure, and ease of construction [3–7]. The coplanar waveguide fed slot antenna in recent times acknowledged much attention due to its advantages such as lower profile wide –bandwidth, easy fabrication. In planar slot antenna two parameters affect the impedance bandwidth of the antenna, the slot width and the feed structure. In this article, a novel circular CPW- fed UWB antenna is proposed. Slots of T and I shapes are etched on the patch. The prototypes with different parameters are fabricated and experimentally verified.

2. ANTENNA DESIGN
The configuration of the proposed antenna is shown in figure 1. The dimension of the antenna is L X W = 33 mm x 22 mm.

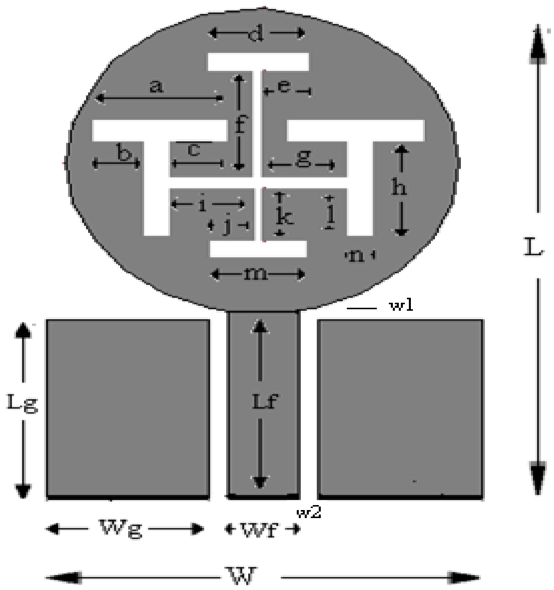

Figure 1: Diagram of proposed antenna

As shown in the figure 1, the antenna consists of circular shape patch consisting T and I-shape slots in it. Two T-shape slots are joined with horizontal line and one I- shape slot is placed between them. The antenna is constructed with the above described patch and fed by Coplanar Waveguide Feed (CPW) feeding. The ground size of the proposed antenna is 12 mm x 8.4 mm. The ground plane is symmetrical at the base line of the feeding strip line. To obtain the optimal parameters of the proposed antenna for UWB application, IE3D, full-wave commercial EM software that can simulate a finite substrate and a finite ground structure, is used. Thus, the proposed antenna design can provide a wide bandwidth while retaining stable performance via the optimized geometrical parameters. The parameters of proposed antenna are shown in Table 1. The rectangular strip feed line has dimensions of 12.5 m × 3.7 mm. The distance between patch and ground is 0.6 mm and between feed and ground is 1 mm.

Table 1: Different parameters of antenna

Parameters	Values (mm)	Parameters	Values (mm)
L	33	W	22.5
Lg	12	Wg	8.4
Lf	12.5	Wf	3.7
w 1	0.6	w 2	1.0
a	7.1	b	2.7
c	3	d	5.3
e	2.3	f	7
g	4.1	h	6.4
i	4.2	j	2.2
k	3.4	l	3.1
m	5	n	1.3

3. SIMULATED RESULTS AND DISCUSSIONS

The simulated return losses and other parameter results are obtained. The return losses of the proposed antenna are shown in Fig. 2. The result shows that the antenna exhibits impedance bandwidth from 4.6 GHz to 11.7 GHz centered at 7.9 GHz. The peak value of return loss is -32 db. This implies that it covers UWB band from 4.6 GHz to 11.7 GHz.

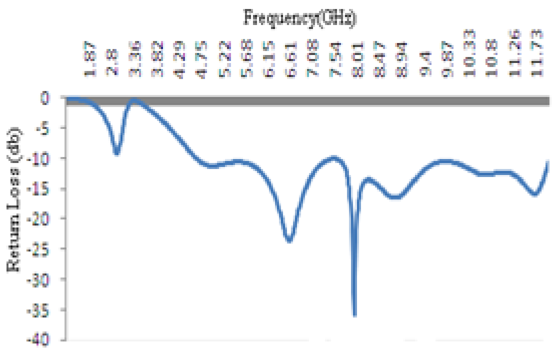

Figure 2: Result of proposed antenna

Fig. 3 shows the parametric study of the proposed antenna. It shows the comparison graph of return losses when there was no slots in patch, there was slots in the patch. When no slot was embedded in the patch, peak of return losses was decreased too much. After adding slots, peak value is increased to higher values and the optimum results are obtained.

Fig 4 also shows the affect of various parameters on the result of antenna. It shows the comparison graph when ground width is increased, when distance between radiating patch and ground plane is increased and when I slot is removed from patch.

When width of ground was increased, peak value of return losses was decreased and when distance between radiating patch and ground plane was increased, it affects the impedance bandwidth. There was no impedance bandwidth in working bands. The peak value of return loss of antenna was decreased to -27 db, when I-shape slot was removed from radiating patch.

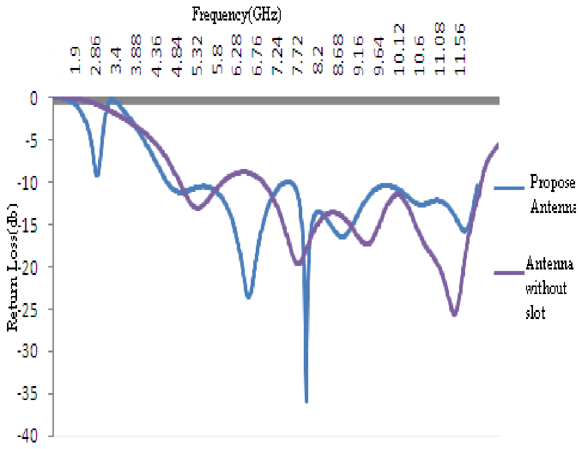

Figure 3: Comparison of result of proposed antenna with and without slot.

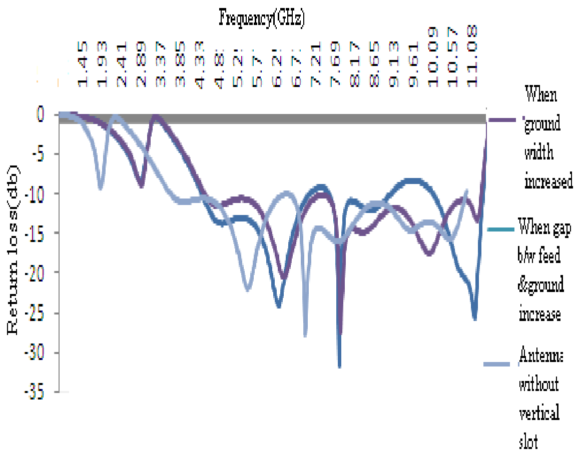

Figure 4: Comparison of return losses of (a) Antenna when ground width increased (b) Antenna when gap b/w feed & ground increased (c) Antenna when I-slot removed from patch.

Fig 5 shows the current distribution of proposed antenna.

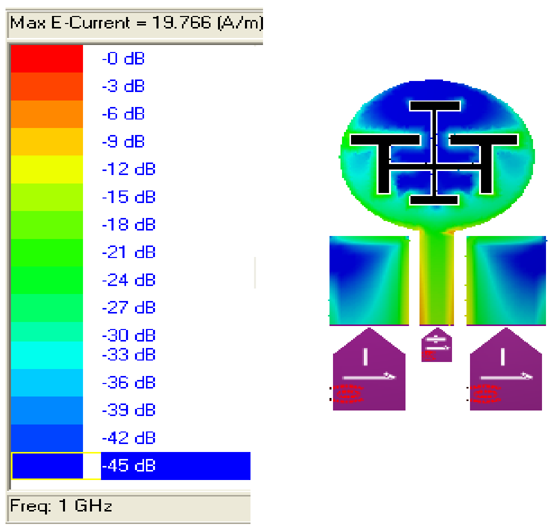

Fig 5: Current distribution of proposed antenna

Current distribution is changed by changing the length and dimensions of patch.The maximum current is 19.6 amperes. Figure 6 shows simulated 2D radiation patterns for elevation and azimuth plane near at resonant frequencies 4.39 GHz. Radiation pattern presents the graphical representation of radiation properties of antenna as a function of space co-ordinates. Fig. 6(a) shows elevation pattern gain display and fig 6(b) shows azimuth pattern gain display at 4.39 GHz. Figure 7 shows 3D radiation pattern of proposed antenna.

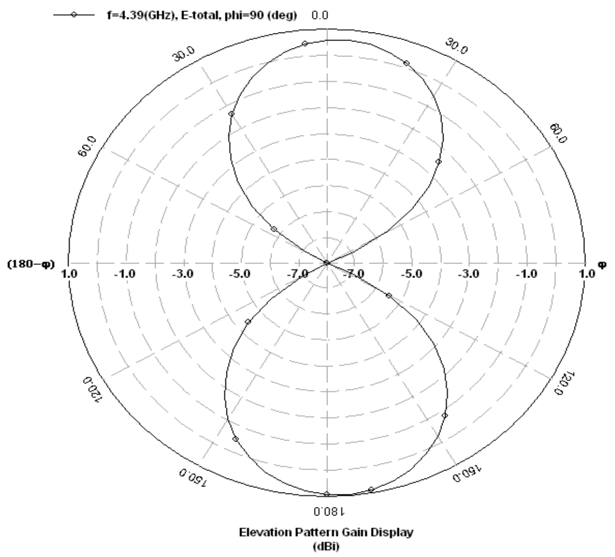

Fig 6(a) Elevation pattern gain display at 4.39 GHz

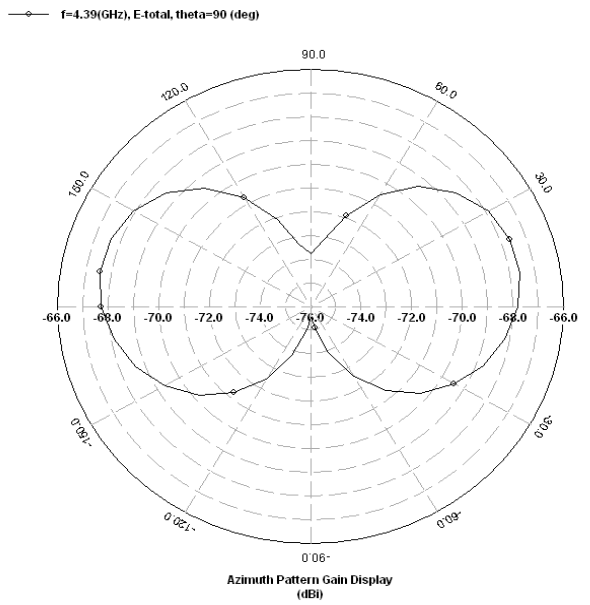

Fig 6(b): Azimuth pattern gain display at 4.39 GHz

Figure 8 shows the gain of proposed geometry. The maximum gain is 5 dbi at 6.3 GHz and 11.7 GHz. Gain of the proposed antenna within the operating band satisfies the requirement of UWB applications.

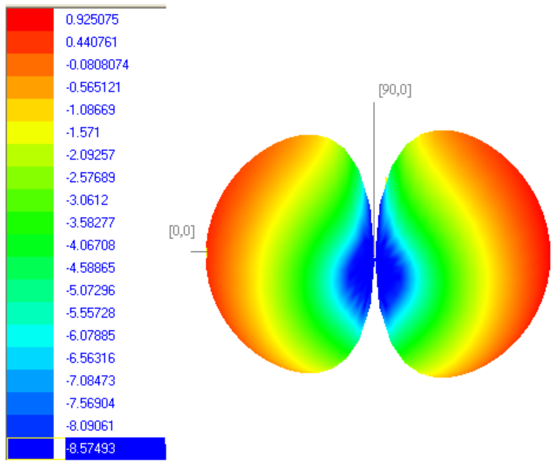

Fig 7: 3D Radiation Pattern of Antenna

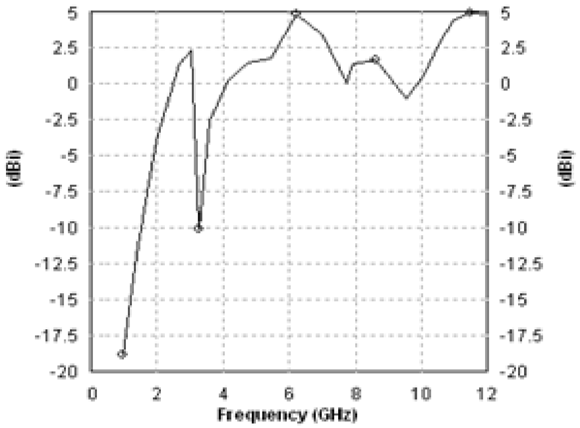

Figure 8: Gain of Proposed Antenna

Radiation efficiency tells how much of input power accepted by an antenna (Pin) it covers to radiated power. Radiation efficiency can also be expressed as the ratio of unloaded quality factor to the radiation quality factor of the antenna. Figure 9 shows the efficiency of proposed antenna. The maximum efficiency is 77.5%.

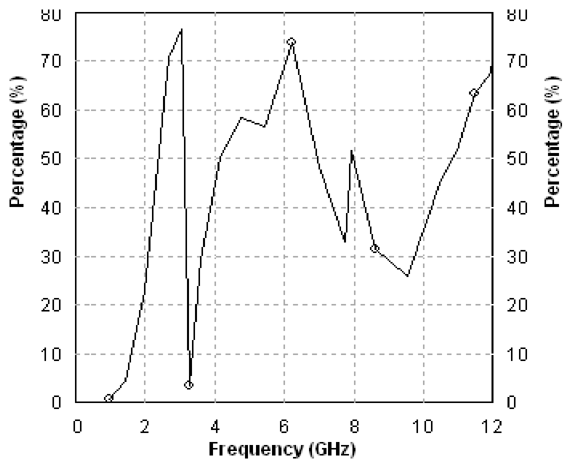

Figure 9 : Efficiency of Proposed Antenna

4. CONCLUSION

A circular patch antenna with slots suitable for UWB applications is proposed. Effects of varying dimensions of key structure parameters on the antenna and their performance are also studied. Moreover, the proposed antenna has several advantages, such as small size, excellent radiation patterns, and higher gains and good efficiency. These characteristics are very attractive for some wireless communication systems for a variety of applications. Proposed antenna exhibits impedance bandwidth from 4.6 GHz to 11.7 GHz.

5. REFRENCES

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